Lead Frame Having A Tilt Flap For Locking Molding Compound And Semiconductor Device Having The Same

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention generally relates to a semiconductor device, and more particularly to a surface mount semiconductor device.

Description of the Related Art

[0002] The adhesion between a molding compound and a lead frame is a very important issue for a surface mount device. If the adhesion strength between the molding compound and the lead frame is not strong enough, the molding compound will be easily separated from the lead frame and the reliability of the device will be thus deteriorated.

[0003] There are many ways to increase the adhesion strength between the molding compound and the lead frame. Figures 1(a) and 1(b) illustrate conventional locking-hole designs for a lead frame. In Figures 1(a) and 1(b), locking holes (11, 12) are formed in the lead frame (10) for increasing the adhesion strength between the molding compound and the lead frame (10). However, such a design can only be applied to a lead frame having a thickness of more than 10 mils. If the thickness of the lead frame is less than 10 mils, the locking holes cannot effectively increase the adhesion strength between the molding compound and the lead frame.

[0004] Figure 2 illustrates another conventional taper edge design for a lead frame. In Figure 2, taper edges (21) are formed at the edges of the lead frame (20) for increasing the adhesion strength between the molding compound (22) and the lead frame (20). Although the taper edges can be formed by a stamping process, the stamping process can only be applied to a lead frame having a thickness of more than 10 mils. If the thickness of the lead frame is less than 10 mils, the taper edges have to be formed by an etching method.

However, the cost for etching the taper edges is very high.

[0005] Figure 3 illustrates a conventional locking hook design for a lead frame. In Figure 3, a large locking hook (34) is formed on the lead frame (30) and a die (33) is attached thereon. Although the large locking hook (34) can effectively increase the adhesion strength between the molding compound (32) and the lead frame (30), it takes a large portion of the lead frame (30) to form the locking hook (34) and thus the lead frame material is wasted, rendering the high cost. In addition, the space for a die is also reduced and thus the electrical capacity of the die is limited.

SUMMARY OF THE INVENTION

[0006] A lead frame having at least one tilt flap for locking molding compound and a surface mount semiconductor device having the same are disclosed, wherein at least one tilt flap is formed on the lead frame such that the adhesion force between the lead frame and the molding compound is enhanced without wasting much lead frame material. In addition, the space for a die and the electrical capacity of the die are increased.

[0007] Preferably, the lead frame comprises a first edge and a second edge, the second edge has a reduced portion extending outward from the lead frame. The at least one tilt flap is provided at the first edge and extended outward from the lead frame and the second edge of the lead frame further comprises at least one tilt flap extending inward towards the lead frame.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions, taken in conjunction with the accompanying drawings which illustrate the embodiments of the present invention, wherein:

[0009] Figures 1(a) and 1(b) illustrate conventional locking-hole designs for a lead frame;

[0010] Figure 2 illustrates a conventional taper edge design for a lead frame;

[0011] Figure 3 illustrates a conventional locking hook design for a lead frame;

[0012] Figure 4 illustrates a surface mount semiconductor device of the present invention;

[0013] Figure 5 illustrates an embodiment of a die-attached portion of a lead frame of the present invention;

[0014] Figure 6(a)-6(c) illustrate different embodiments of the lead frame of the present invention;

[0015] Figure 7 is a schematic diagram for measuring the adhesion forces of the embodiments of the present invention; and

[0016] Figure 8 is a table illustrating measured results of the embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Figure 4 illustrates a cross-sectional view of a surface mount semiconductor device, such as a rectifier, in accordance with the present invention. The semiconductor device includes a bottom lead frame (40), wherein the thickness of the bottom lead frame (40) is preferably less than 10 mils and has at least one tilt flap or a hook (45); a die (43) is attached on the bottom lead frame (40); a top conductive finger or wire (41) is attached on the die (43) by a conductive material (44), such as solder; and a molding compound (42) is provided for molding the semiconductor device, wherein the molding compound (42) surrounds the at least one tilt flap (45) to thereby increase the adhesion strength between the molding compound and the lead frame and to "lock" the two together. Preferably, the bottom lead frame (40) comprises a first edge and a second edge, the second edge including a "reduced portion" (described further below). The at least one tilt flap 45 extends outward from the bottom lead frame (40) and is provided at the first edge and extends outward from the bottom lead frame (40). The second edge of the bottom lead frame (40) includes at least one tilt flap (46), and preferably two tilt flaps, extending inward toward the bottom lead frame (40).

[0018] Figure 5 illustrates one embodiment of a top view of a die-attached portion of a lead frame according to the present invention. The lead frame can be used in the semiconductor device as shown in Figure 4. The lead frame is provided with at least one tilt flap or hook (55) for locking a molding compound. The die-attached portion (50) of the

lead frame has a first edge and a second edge. In the embodiment illustrated, the second edge has a reduced portion (i.e., a portion of the lead frame eliminated from the width of the lead frame extending outward from the die-attached portion (50)) and two tilt flaps (56). The at least one tilt flap (55) is provided at the first edge and extended outward from the side-attached portion (50). The second edge of the die-attached portion (50) includes at least one tilt flap (56), and preferably two tilt flaps, extending inward to the side-attached portion (50).

[0019] Figures 6(a)-6(c) illustrate top views and corresponding side views of additional embodiments of a lead frame according to the present invention. Figure 6(a) refers to a lead frame (60) having a tilt flap (65) at its first side without a reduced portion at its second side. Figure 6(b) refers to a lead frame (60) having a tilt flap (65) at its first side with a reduced portion (61) at its opposite second side. Figure 6(c) refers to a lead frame (60) having a tilt flap (65) at its first side with a reduced portion (62) and two tilt flaps (66) at its second side.

[0020] Figure 7 is a schematic diagram for measuring the adhesion forces of the embodiments shown in Figures 6(a)-6(c). The tensile strength of the surface mount device (SMD) (71) can be obtained by pulling the bars (72). The measured results are shown in Figure 8. It is known from Figure 8 that the embodiments of a lead frame according to the present invention as shown in Figures 6(a)-6(c), and particularly in Figure 6(c), have significantly enhanced the adhesion force between the lead frame and the molding compound without wasting much lead frame material. In addition, the space for the die and the electrical capacity of the die are increased.

[0021] Although the present invention and its advantage have been described in detail, it should be understood that various changes, substitutions and alternations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims.